UV210 optical microresonators on pedestal

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Introduction

Integrated optics is an equivalent of microlectronics but with light. This is a key field in **new technologies** due to its potential of low-cost and high-speed integrated circuits. **Microresonators (MRs)** are major components thanks to their properties as filters or sensors. **Whispering Gallery Modes (WGMs)** rules the MRs' physics. These modes appear near the MRs' surface, when **light is confined by total internal reflections**. **Polymers** are well adapted materials due to their wide range of properties. We use the **UV210**, which refractive index is tunable. Moreover, **pedestals** offer interestig possibilities by **improving efficiency** and giving new geometries for coupling light into MRs.

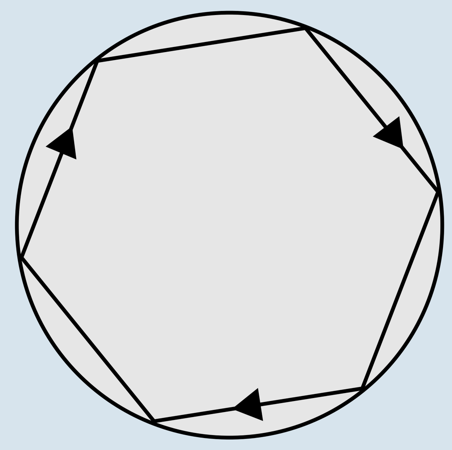

Fig. 1 : schematic WGM

Cleanroom protocole

Process steps	Parameters
Spin-coating (v, a, t)	900 rpm, 5000 rpm.s^{-1}, 30 s
Softbake (t, T)	3 min at 140°C
Exposure dose (E, t at λ_{DUV}= 248 nm)	20 mJ.cm^{-2}, 10 s
Post-exposure softbake(t, T)	1 min at 120°C
Development (product, t)	Microposit MF CD-26, 30s
Final softbake (t, T)	5h at 125°C
Buffer HF Improved (Transene) etching (t)	90 s

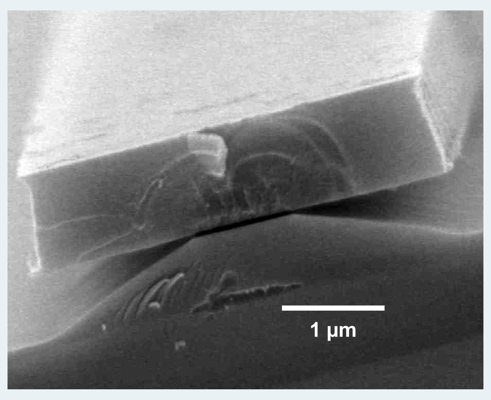

Fig. 2 : 4 µm waveguide on pedestal (SEM imagery)

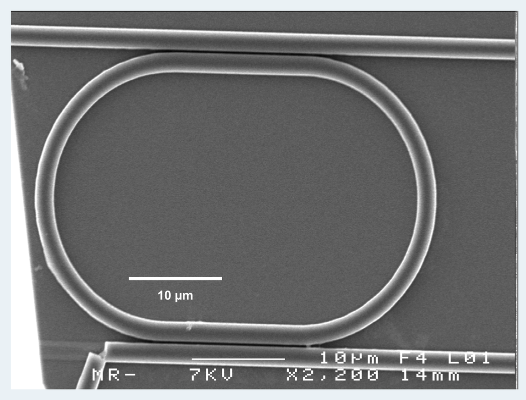

Fig. 3 : Racetrack MR (SEM imagery)

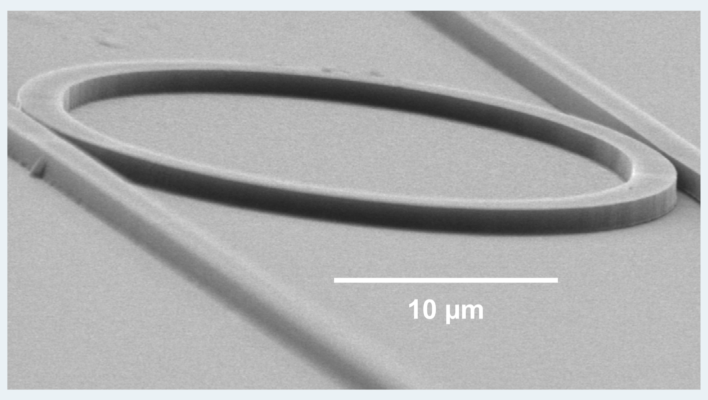

Fig. 4 : Ring microresonator (SEM imagery)

Optical characterizations and results

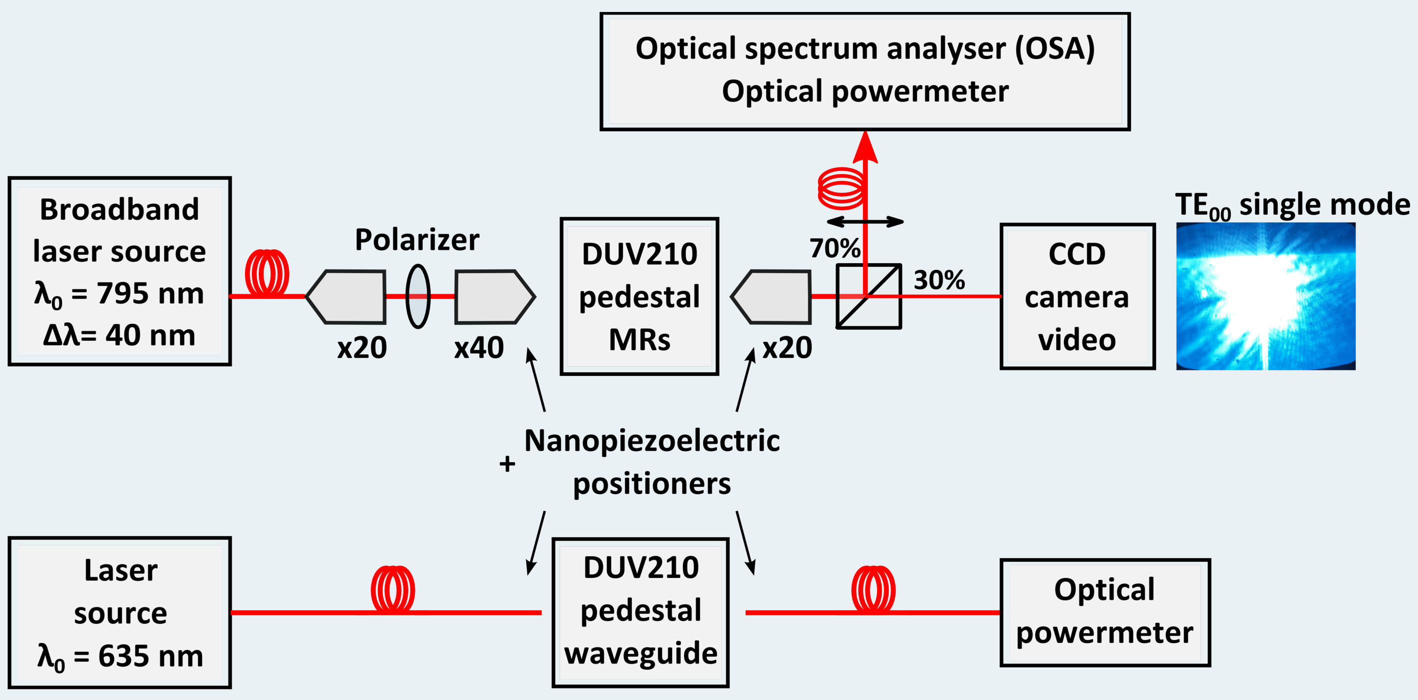

Fig. 5 : Micro-optical injection plateform for optical losses measurements and spectral analysis of resonances into MRs.

Propagation losses measurements determine the amount of light lost during propagation in a rib waveguide on pedestal by cut-back method.

Cut-back method : optical losses determination by measuring the relative variation of output power for different lengths of the same waveguide. Only the output face is cleaved to have the same injection conditions.

Beer-Lambert law :

$$10\log(P_j/P_i) = \alpha.(L_i-L_j)$$

where $P_{i,j}$ is the output power for respectively L_i and L_j and α is the optical losses in dB/cm.

We obtain **losses around 20 dB/cm.**

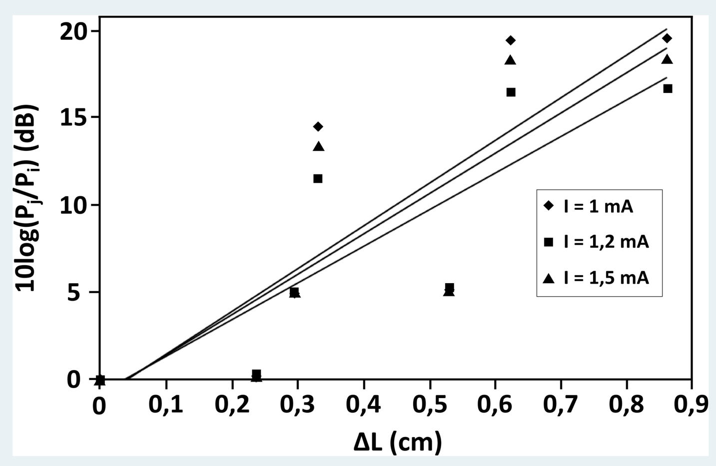

Fig. 6 : graphical measurement of optical losses

Spectral analysis : resonances in MRs

The WGM physics only allow light to enter into the MRs only if the **wavelength** is an **integer multiple of the geometrical perimeter**. Using a broadband source, the output spectrum (after the MRs) corresponds to the input one minus the **resonant wavelenghts**. The distance between two resonant wavelengths is called **free spectral range (FSR)** and can be measured on spectra or calculated by :

$$FSR = \lambda_0^2/(P.n_{eff}^{grp})$$

where P is the geometrical perimeter of the MR and **n_{eff}^{grp} the effective group index**, relevant index for a broadband source. Measured **FSR** are **2.86 nm for the ring microresonator** and **2.71 nm for the racetrack shape. FWHM (δλ)** give a **quality factor greater than 500**. Those experimental values leads to an **n_{eff}^{grp} = 1.69** instead of 1.552 for the UV210 polymer.

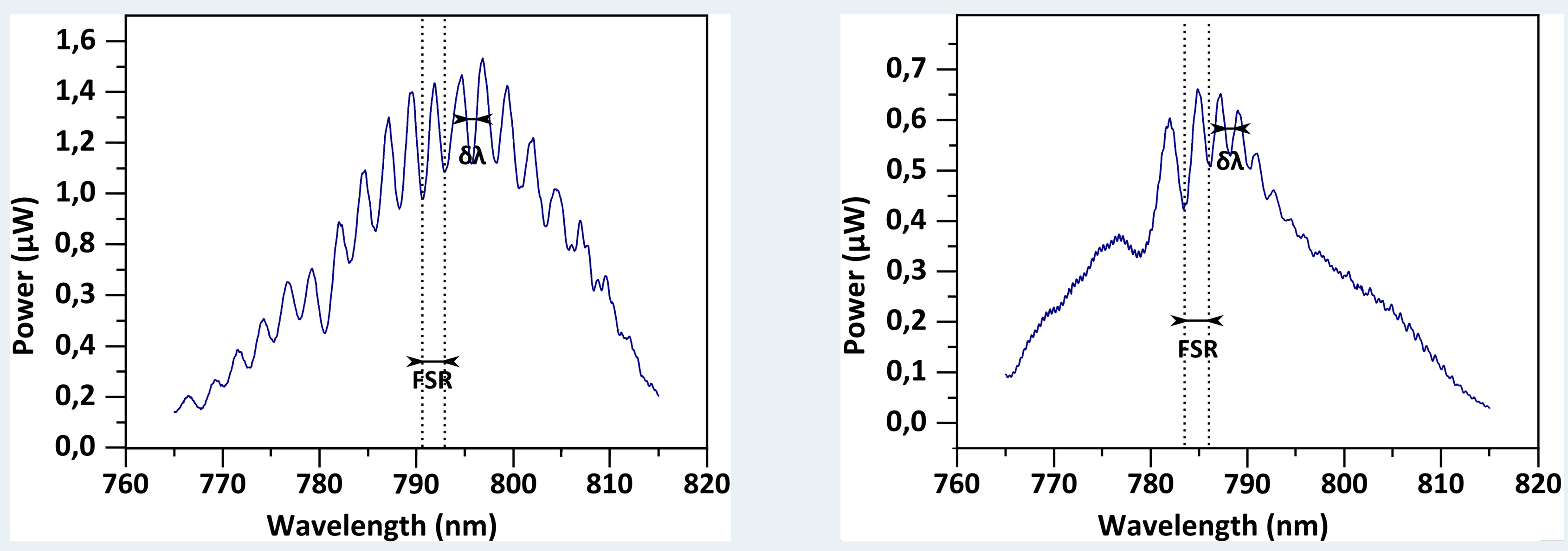

Fig. 7 : experimental response of a red broadband source into a racetrack pedestal MR (on the left) and aring pedestal MR (on the right)

Conclusion

> Deep UV lithography + chemical etching = polymer optical components on pedestal for integrated optics.

> Optical characterizations : losses around 20 dB/cm, FSR = 2.86 nm (ring MR), 2.71 nm (Racetrack MR), n_{eff}^{grp} = 1.69.

> Building deep UV210 optical components on pedestal, from waveguides structure to MRs in a simple and reproductible way.

> These specific UV210 polymer family components are quite easy to produce and they can be implemented for filters or futures optical sensors applications.